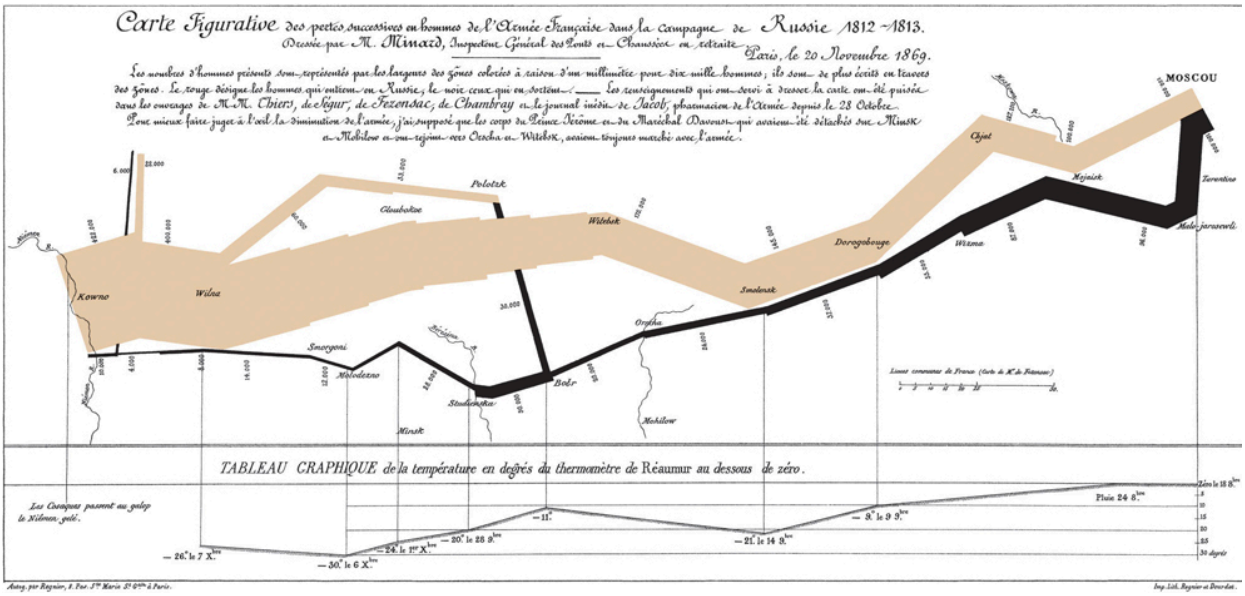
CS-GY 6313 B: Information Visualization

New York University
Fall 2024

Welcome to CS-GY 6313 B: Information Visualization. Below is one of the most famous data visualizations of all time about Napoleon's invasion of Russia. The total number of soldiers, their location, and the total loss of life over distance and time are visualized. This is an amazing amount of data shown in one simple image!



This syllabus will outline essential information about this course including when and where it meets, office hours, and how final grades will be calculated.

Logistics

Professor: Dr. Niall L. Williams
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TA: Lokesh Shanmugam
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Class location: Jacobs Academic Building Room 473
Class time: Thursdays @ 11 AM - 1:30 PM

The easiest way to contact me is via email or office hours. Office hours are TBD.

Course Prerequisites

The coursework includes projects that require visual programming using Python/Matplotlib (but any language for your final project with freeform choice). While previous knowledge is not required, being proficient and comfortable with programming is a fundamental prerequisite for this course. Previous experience with computer graphics, algebra, geometry, data science, and analysis can also help but is not required.

Course Description

Being able to analyze and present data visually has become one of the most important skills for work in data science, finance, and related fields. Information Visualization teaches you how to design effective interactive visualizations of complex data for data understanding discovery and presentation.

The course is a blend of theoretical and practical knowledge aimed at developing a well-rounded set of skills to ideate, design, implement, and evaluate sophisticated data visualization projects.The course will proceed with 3 meta sections: 1) information visualization techniques/models of visual encoding, perception, and practical applications; 2) fundamental data processing and basic computer graphics; 3) modern medium visualization topics such as VR/AR, machine learning, and multimodal interfaces. Through the course as an example, you will develop core academic and industrial skillset including reading/writing, presentation, and mathematical/computational skills.

The theoretical part contains low-level optical and computational methods of how individual pixels are drawn on the screen, and how they are perceived by the human eyeball, the retina, and the brain. The practical part aims at teaching the skills needed to develop effective interactive data visualizations for analysis and presentation.

The course also includes a series of small practical projects which enable students to gain experience with the development of fully-working interactive graphics/visualization techniques. The final project, with the freedom to select among several topics, is organized in a way to simulate conditions happening in real-world data analysis and communication projects and includes activities to gain feedback from the instructor and the teaching assistants.

Course Objectives

- Develop low-level knowledge of visual computing, including basic algebra, computer graphics, and optics.

- Develop an understanding of the unique human visual and cognitive system while perceiving digital content.
- Identify what kind of problems visualization can solve.
- Explain why and when visualization works.
- Develop analytical questions for a data analysis problem and develop appropriate data manipulations and graphs to answer them.
- Learn how to evaluate a visualization project: identify the elements of a project that need to be evaluated and strategies to carry out effective evaluations.
- Identify the appropriate graph for a given problem.
- Describe what the limitations of a visualization method are and how they can be overcome.
- Recall the set of marks and channels visualization methods can use and describe their advantages and disadvantages.
- Describe a visualization in terms of its encoding strategy (marks and channels used) and identify its potential limitations.
- Describe the concepts of channel effectiveness and expressiveness and demonstrate how to apply them in the design and evaluation of data visualizations.
- Read and summarize the state-of-the-art research literature.
- Gain hands-on experience on modern and interdisciplinary visualization topics and platforms, such as VR/AR and deep learning.

Course Structure

The course includes lectures, mini (programming) assignment, readings, reports, and design/development of visual computing projects.

Textbooks

There are no required textbooks. However, the following books are those that contain most of the information taught in the course:

- Visualization Analysis and Design, Tamara Munzner, CRC Press 2014
- Envisioning Information, Edward Tufte, 1990

Other recommended texts are:

- Fundamentals of Computer Graphics, Steve Marschner, Taylor & Francis Group, LLC 2016
- Published articles in IEEE Vis/TVCG and ACM ToG/SIGGRAPH

Course Requirements

The course requires:

- Projects: development and submission of assigned mini-assignments and projects;
- Literature reading and survey: based on your selected project, summarize and present previous literature.

Attendance will not be taken, but it is highly recommended so that you can follow along with the course material. There will be no recordings of lectures and the content comes from a mixture of textbooks, research papers, and talks, so following along without being present will be difficult. Furthermore, attending class gives you the opportunity to meet your peers who may end up being your partners for the final project, or life-long friends and colleagues!

Grading breakdown:
- Assignments: 15% x 4
- Article survey report: 10%
- Final project: 30%

For special situations such as sickness, quarantine, religious festivities, family issues, etc, the deadlines of each element may be extended and flexible to accommodate your need. You should send me a note ahead to discuss and for approval. Otherwise, we will deduct 10% per day of the corresponding item.

Assignments and Final Project

The four assignments consist of an assigned data set and a problem the visualization is supposed to solve. The solution requires designing a solution and implementing it in Python.

Examples of the final project can be 1) applying visualization for your own interested application or data, or 2) your current research project with a visualization component, or 3) a larger-scale implementation of state-of-the-art research. You can freely choose any topic/article that you like. Various options will be provided. Early discussion with the instructor on the final project topic and scope is **strongly recommended.**

Late policy: Submissions will generally be due at 11:59pm. A total of 3 “late credits” will be given (1 credit = extend deadline by 24 hours). A linear late penalty will be applied to assignments, up to 3 days. For example, if your assignment is 12 hours late, you will receive a 16.66% penalty (12/72 = 16.66). Late assignments due to illness or unexpected events can be excused with doctor’s notes or other forms of written indication. **You cannot use any late credits on submissions related to the final project (proposal document and final submission).**

Literature Reading and Survey

An essential skill is to read and summarize prior work and literature. After selecting the final project topic, you will start searching and summarizing prior literature along the same direction. A 4-page survey will be written to assess your domain-specific knowledge in both breadth and depth.

Schedule

Date	Topic	Assignments
Week 1 (9/5)	Introduction to data visualization, syllabus details	
Week 2 (9/12)	Data types, visualization techniques & tools	
Week 3 (9/19)	The human visual system	Assignment 1 released.
Week 4 (9/26)	Visual encoding + perception	
Week 5 (10/3)	2D visualization - spatial data	Assignment 1 due. Assignment 2 released.
Week 6 (10/10)	2D visualization - temporal data	
Week 7 (10/17)	2D visualization - network data	Assignment 2 due. Assignment 3 released.
Week 8 (10/24)	3D visualization - basic projection and graphics	
Week 9 (10/31)	Animation	Assignment 3 due. Assignment 4 released.
Week 10 (11/7)	Final project proposals	
Week 11 (11/14)	Uncertainty visualization	Assignment 4 due.
Week 12 (11/21)	Storytelling, ethics, and misinformation	
Week 13 (11/28)	🦃 Thanksgiving Break 🦃	
Week 14 (12/5)	Modern topics: deep learning/VR/AR/interaction	
Week 15 (12/12)	Final project presentations	

Note that the schedule is fairly volatile – depending on the class' learning pace and interests, topics may be added, removed, or rearranged

Quoting Policy and Collaboration

The work students submit for individual assignments and class projects must be their own original work. When ideas are borrowed from existing work it is necessary to provide citations and a clear statement that describes which part has been adopted and which is original.

For assignments, students are not allowed to collaborate with their peers or copy from open-source solutions. The assignments must be produced and submitted individually. For the final project, students are allowed to work in a team of up to 3 students.

Academic Dishonesty

Copying work or cheating is not allowed. I prefer to trust each one of you. Please know that academic dishonesty is a very serious issue and you might get in very serious trouble if caught cheating. Students caught in dishonest behavior get an F score for the course and are reported to the school.

Please refer to NYU Tandon's code of conduct to guide your academic behavior: https://engineering.nyu.edu/life-tandon/student-life/student-advocacy/student-code-conduct

Moses Center Statement of Disability

If you are a student with a disability who is requesting accommodations, please contact New York University's Moses Center for Students with Disabilities at 212-998-4980 or mosescsd@nyu.edu. You must be registered with CSD to receive accommodations. Information about the Moses Center can be found at www.nyu.edu/csd. The Moses Center is located at 726 Broadway on the 2nd floor.

Religious Observance Policy

New York University is committed to providing an inclusive and equitable learning environment for students of all religious and spiritual backgrounds. In accordance with university policy and state law, students may request reasonable accommodations for religious holidays and observances without penalty.

If you anticipate missing class or having conflicts with academic obligations (e.g., exams, assignments) due to religious observances, please notify me as early as possible, ideally at the beginning of the semester. Failure to provide timely notification may limit available accommodations.

Students will not be penalized for absences due to religious observances, and such absences will not count against any attendance policies.

For more information, please refer to the full NYU Policy on Academic Accommodations for Religious Holidays and Observances: https://www.nyu.edu/about/policies-guidelines-compliance/policies-and-guidelines/university-calendar-policy-on-religious-holidays.html

Generative AI Usage Policy

It is important that the work required by the course (code, written reports, presentations) is yours. You are not allowed to use ChatGPT or other AI tools for any purpose other than idea generation. When you use any of these tools, you must include a note describing how you used them with the assignment.